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The Interaction of Suffixation with Synonymy and Antonymy

by

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A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Master of Science

in

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Abstract

This thesis reports on two psycholinguistic experiments that explore the question of how synonyms and antonyms are linked in the Mental Lexicon. The experimental results confirm theoretical expectations that synonymic and antonymic links are fundamental cognitive relations among lexical items. The results also suggest that the nature of these relations may not be identical because it was found that synonymic and antonymic pairs behaved differently in the two experimental paradigms and that they also showed differences in the way they interacted when suffixation was added as a factor. The relevance of these findings to methodological issues in psycholinguistic experimentation is discussed and the implications for further research are outlined.

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1. Introduction

1.1 Preliminaries

Within the mental lexicon the storage of lexical items is governed by multiple and diverse organizational patterns. These patterns are exhibited in many fundamental lexical-semantic relations and basic morphological relations among words. An example of a lexical-semantic relationship can be seen in the word pair cat-dog, where both items are related to each other through membership in the superordinate category animal. An example of a morphological relationship can be seen in the word pair manage-management, where the items are related to each other (both in meaning and morphology) in a regular and predictable manner by English lexical rules of derivational morphology.

Semantic and morphological relations such as the ones above are important to the structure of the mental lexicon and they point to the fundamental role played by links among lexical items in the organization of words in the mind. Evidence that systematic links or pathways somehow connect semantically related words is presented most straightforwardly in word generation studies in which a participant is given a word and asked to produce the first word that comes to mind (e.g., Goldfarb and Halpern, 1984). Since the word that comes to mind is a

related word, and never a completely unrelated or random one, these words must be linked to each other within a "semantic network". The result of this semantic linkage is that, once one of the words is accessed, other words within the "network" can be more easily accessed.[1]

Evidence for morphological links in the mental lexicon have come from experiments that have shown that a word (the experimental target) is more quickly recognized when it is preceded by a word that is morphologically related to it (the experimental prime) (Marslen-Wilson, Tyler, Waksler and Older, 1994). It has been shown that a presentation of a prime word such as happy will decrease the response time to recognize the morphologically complex target happiness (Murrell and Morton, 1974). Decreased response time can be viewed as reflecting ease of processing.

The well-documented evidence for the existence of semantic and morphological links among lexical entries gives rise to the question of the relative strengths of semantic and morphological links and whether both positive and negative links can occur. A positive link can be equated with a facilitation effect, whereby items are more easily accessed following the processing of related items. Facilitation is often measured as a decrease in reaction time to a stimulus. A negative link, on the other hand, is associated with inhibition in which the access of one word may actually result in the related word requiring more processing to be subsequently

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[1] It is possible that not all semantic links within a network are facilitatory. Inhibitory links would result in words being more difficult to access once one word within the network was activated.

recognized. Inhibition is often measured as an increase in reaction time to a stimulus.

The goal of this thesis is to contribute to knowledge in this domain by focusing on the fundamental semantic relations of synonymy and antonymy and the extent to which these relations interact with morphological complexity. Synonyms, in simple terms, are "words or expressions that have the same meanings in some or all contexts (e.g., buy and purchase)" (O'Grady and Dobrovolsky, 1996, p. 646). Antonymy, on the other hand, represents a semantic relation in which "words or phrases... are opposites with respect to some component of their meaning (e.g., big and small) (O'Grady and Dobrovolsky 1996, p. 624).

1.2 Outline of Thesis

The relations of synonymy and antonymy and their interaction with morphological complexity are examined from an experimental psycholinguistic perspective in this study. Specifically the research addresses the following questions:

(1) Is there a difference in the links formed between words that are related by synonymy and words that are related by antonymy?

(2) Are semantically related words affected by the addition of suffixes to one or both items in the pair?

(3) Do implicit and explicit tasks generate different response patterns for word pairs related by synonymy and antonymy?

With the first question I inquire into the nature of semantic links. Are all links qualitatively similar in that upon recognition of any word

within a "network" all other words will be somewhat facilitated? Or, is it possible that while some links in the "network" are facilitatory, others are inhibitory? In my experiments I explore the representation of synonymy and antonymy by looking at the relative processing of pairs of synonyms and pairs of antonyms.

In order to answer the second question, the members of synonymic and antonymic pairs which differ in their internal morphological structure will be examined. Specifically, one item in each pair might be morphologically simple (without any suffixation) while the other is morphologically complex (suffixes will be added). Pairs with similar morphological structure will also be examined. For example, a pair with no suffixation would be a simple-simple pair such as big-large; a pair with one suffixed item would be simple-complex (copy-original) or complex-simple (wonderful-great); and a pair with both items containing suffixes would be a complex-complex pair (talkative-speechless).

The third question involves comparing the results from experiments that employ fundamentally different techniques, each designed to tap a different level of lexical processing. Specifically, while one experiment evoked explicit metalinguistic judgments about morphological relatedness, the other employed a semantic priming task which focused on implicit processing. My report of the results of these experiments is organized in the following manner.

In this first chapter I have discussed my motivation for doing this research as well as outlining the goals and research questions for my study. Chapter 2 outlines the theoretical and experimental groundwork which has motivated the present research. This chapter includes a review of the literature on the semantics of synonymy and antonymy. A summary of psycholinguistic studies that have compared synonymy and antonymy is also given. The chapter concludes with a brief discussion of the role of suffixation in the relations of synonymy and antonymy and its place within my investigation.

Chapter 3 details the stimulus development methods and the stimulus selection criteria for the experimental materials. This chapter also reports on a pretest (made up of rating tasks for both the synonym and antonym pairs) that was used to finalize the choice of stimulus materials for the on-line experiments.

In Chapter 4, the first on-line experiment, a relatedness judgment task, is described. This experiment probes the explicit processing of synonyms and antonyms. It is an on-line task which measures the time required to judge pairs of words as being related or not. The results from this experiment are compared to the ratings found in the pretest discussed in Chapter 3.

The second experiment, a lexical decision task using the priming paradigm, is discussed in Chapter 5. This experiment targets the implicit processing of synonyms and antonyms. It involves a non-paired semantic

priming task, examining the response times to lexical items primed by their synonyms or antonyms as compared to priming by semantically neutral words. The results from this experiment are compared to the findings of Experiment 1.

In Chapter 6 these two experiments are brought together for discussion and comparison. The results from both the explicit and implicit processing tasks are compared. In this last chapter I also discuss the limitations of my study and provide implications for further research in the area.

2. Semantics, Psycholinguistics, and Suffixation

2.1 Introduction

Lexical-semantic representations are often taken to be "relational structures" in which the meaning of a word is determined by its relation to the meanings of many other words (Lyons, 1977). Put another way, words can be considered to receive their defining qualities through the existence of "network-like" connections with other items. These connections can be taken to represent the lexical-semantic relations.

In Section 2.2 of this chapter, I outline the relations of synonymy and antonymy within the larger context of semantic relations. In this section, the concepts of synonymy and antonymy are described and subtypes of these relations are specified and defined. This section also describes psycholinguistic evidence for the existence of semantic relations and reports on two experiments that directly compare synonymic and antonymic relations. Following the description of semantic relations, Section 2.3 describes the issue of suffixation and its role in these experiments. The focus, in this section, is on the representation of suffixed words in the mental lexicon and how these multimorphemic words embody semantic links.

2.2 *Semantic Relations*

Although a word is initially recognized by properties of its surface form, this is just the beginning of the process of accessing lexical-semantic representations. It is through the lexical-semantic representations that the subsequent processes of parsing and comprehension can occur (Marslen-Wilson, et al., 1994). The organization of these representations falls within the domain of lexical semantics. Traditionally, the descriptive aims of lexical semantics have included: (a) an attempt to represent word meaning; and (b) an attempt to show how meanings of words are interrelated (Saeed, 1997). These two aims can be considered to be closely related, as words can be defined in part by their relations to other lexical items within a given language.

In theories of the mental lexicon and semantic memory, it is assumed that entries for lexical items are organized on the basis of relations among words (Gross, Fischer, and Miller, 1989). According to these lexical theories, any lexical item may be represented simultaneously in a number of different semantic relations. There are numerous types of meaning relations. Some examples of these are: synonymy (similar lexical items), antonymy (opposing lexical items), hyponymy (subordinate category membership), and meronymy (part-whole relationship). Yet, not all such relations can be considered as being of equal importance. Two meaning relations that are regarded as central to any theory of how words are organized within the human lexical store are the relations of

synonymy and antonymy. The special status of synonyms and antonyms can be seen from findings of word association tasks. In these tasks participants are asked to provide the first word that comes to mind upon presentation of a lexical item. Results show that many, although not all, of the associated words that are produced by participants represent synonymic and antonymic relations. In Sections 2.2.1 and 2.2.2 these two relations are discussed in detail.

2.2.1 Synonymy

According to Saeed (1997, p. 65), synonyms are "different phonological words which have the same or very similar meanings". Some examples of synonymous pairs are: couch-sofa, boy-lad, and toilet-lavatory. From these examples it can be noted that words that are completely synonymous are very difficult to find. This is because many words that are considered as synonymous actually have different patterns of distribution. The uses of a word and its synonym may refer to the same concept but may be used in different situations, different contexts, or different dialects. For example, the pair toilet-lavatory refers to the same basic concept but its members belong to different dialectal registers. A pair of words that are perfect synonyms, that is, a pair containing words that are able to be substituted for each other in any and all contexts, is very rare and may not exist at all. In order to be considered synonyms, though, the two lexical items must contain a significant amount of semantic overlap and differ only in peripheral traits (Cruse, 1986).

Cruse (1986, p. 265) notes that "...some pairs of synonyms are 'more synonymous' than other pairs". This statement suggests the notion of a "scale" of synonymy. According to Cruse (1986), this scale can be considered to range from the idea of absolute synonymy to the notion of zero synonymy. A definition of absolute synonymy is relatively easy to formulate. On the other hand, zero synonymy is a very unclear notion. For example, do the pairs big-small and cheap-purple both represent non-synonymy to the same degree?

Cruse (1986) defines two types of synonyms; cognitive synonyms and plesionyms. Cognitive synonymy can be considered to be a relation that exists between two items that are syntactically identical and would have equivalent truth conditions in the same sentential frame. Examples of cognitive synonymy are: dog-canine, and umpire-referee. Plesionyms can be distinguished from cognitive synonyms in that they do not require the members to result in equivalent truth conditions when they are placed into sentences. Examples of plesionymic pairs are: foggy-misty, tap-rap, and murder-execute. Neither of these types exhibit any examples of true synonymy.

In order to compensate for this lack of true synonymy, psychologists have introduced the following phrases: "similarity of meaning", "semantic distance", and "semantic similarity". The addition of these phrases has allowed synonymy to be viewed as a continuous variable in which identity of meaning is a matter of degree (Miller and Charles, 1991).

Synonymy considered as a continuous variable will be assumed for the experiments in this study.

2.2.2 Antonymy

In traditional terms, antonyms are words with opposite meanings (Saeed, 1997). Antonymy, or linguistic opposition, is considered by many researchers to be an important principle governing a language's internal structure, at least within its lexical store (Deese, 1964; Lyons, 1977; and Richards, 1967).

On first inspection, English antonyms seem to fall into two descriptive categories. One category consists of morphological antonyms, where the opposite of a lexical item is formed by the addition of a negating affix. The antonymous pair, in this case, is formed through a language's word formation rules. Examples of such antonymous pairs include happy-unhappy, continue-discontinue, and eligible-ineligible. The other main type of antonymy consists of lexical opposites in that are not morphologically related to each other. Examples of this type of opposition are pairs such as happy-sad, fail-succeed and up-down.

Antonymous lexical items can be viewed as words that portray simultaneous closeness and distance (Cruse, 1986). Antonyms are typically word pairs that share all but one dimension of their meaning. In this way, words that portray an opposite lexical relationship can also be considered to be semantically similar. When looking at antonyms, it seems that there are in fact many types of relations which seem to involve lexical items

that can both be viewed as consisting of similar features and yet are incompatible or contrastive in some aspect of their meaning. According to Saeed (1997), the main types of lexical opposition include complementary pairs, gradable antonyms, reversives, and conversives, whose properties are outlined below (types of antonyms are also outlined in Lyons, 1977; Cruse, 1986; and Lehrer and Lehrer, 1982).

Antonyms that are "complementary pairs" represent a binary opposition between lexical items. In a binary relationship, if one item has a positive truth value then it is implied that its complementary antonym must have a negative truth value. Examples of this type of opposition includes dead-alive, pass-fail, and hit-miss. In all these examples it can be seen that affirming the positive of one necessitates the negation of the other (if something is alive it is not dead).

"Gradable" antonyms refer to the relationship between opposites where a comparison is involved. The positive of one term does not necessarily imply the negation of its gradable opposite. This relation has two major identifying characteristics: there are usually intermediate terms between the gradable antonyms (e.g., warm is between the pair hot-cold) and gradable antonyms are usually context-dependent terms (thus a thick paper is thinner than a thin person).

"Reversives" represent an antonymous relationship between items describing movement. One of the terms describes a movement in one direction and the other describes the exact same movement in the

opposite direction. Examples of such pairs are push-pull, ascend-descend and enter-leave.

The fourth type of lexical opposition, "conversives", describes a relationship between two elements that are assessed from opposing viewpoints. One of the items is a description of a term from one vantage point while the other item describes the same relationship from a differing and usually opposing viewpoint. This can be seen in such pairs as own-belong, above-below, and employer-employee.

2.2.3 Psycholinguistics and Semantic Relations

In the above discussion of synonymy and antonymy it was noted that both types of relations consist of lexical pairs in which a great deal of semantic overlap exists. The difference between the relations is that, although neither relation contains pairs that represent perfect synonymy or perfect antonymy, the attributes across which synonymic and antonymic relations differ vary by degree. In synonymy, the semantic attributes that result in two items not being absolute synonyms are only peripheral traits of the meanings of the lexical items; in antonymy, however, the differing aspects are the important and essential aspects of their meaning.

This section describes some psycholinguistic evidence for the existence of semantic relations as one of the linking elements among lexical items in the mental lexicon. Experiments that have directly compared synonymy to antonymy will also be discussed.

A great deal of psycholinguistic research has focused on the role that semantic knowledge plays in the organization of the mental lexicon (e.g., the semantic priming studies of Marslen-Wilson, et al., 1994; Moss, Ostrin, Tyler, & Marslen-Wilson, 1995; and Kiger and Glass, 1983). A consistent finding is that when a target (e.g., cat) is preceded by a prime (e.g., dog) that is semantically related to it, the prime facilitates the processing of the target, as compared to a situation in which the target is preceded by a non-related control word. The usual explanation for such results makes reference to spreading activation in which activated concepts (the primes) are a source of spreading activation which activate nearby related concepts (the potential targets) (Collins and Loftus, 1975).

Some of these priming studies have focused on only one semantic relation. For example, Marslen-Wilson, et al. (1994) chose to use only synonym pairs in their experimental group of semantically related prime-target pairs. These pairs were not related to each other morphologically nor did they have any systematic phonetic overlap. Other studies have focused on the priming ability of words and their semantic associates, regardless of the specific semantic relationships involved (Kiger and Glass, 1983; and Den Heyer, Goring, Dannenbring, 1985). In these studies all types of lexical-semantic relations were considered to have equal status and importance within the mental lexicon. More recently, however, a study by Moss, et al. (1995) compared priming effects for category coordinates (e.g., brother-sister) and functionally related items (e.g.,

orchard-apple). In none of these studies, however, is it possible to determine what types of processing differences, if any, exist between synonymous pairs and antonymous pairs. A few studies have directly compared the two relations but problems exist with each of these.

In one study, which focused on particular semantic relations (Rychlak, Barnard, Williams, and Wollman, 1989) it was found that no differences exist between participants' abilities to form conceptual relationships of synonyms and antonyms. This study employed a concept formation methodology and showed that participants were just as capable of learning an antonymic pattern as following a synonymic pattern. The authors' concluded, from this study, that participants were equally sensitive to the concepts of antonymy and synonymy.

One problem with this study is that, although it shows that participants can acquire concepts of antonymy and synonymy with equal ease, it was not able to determine whether one of the relationships had a processing advantage. Off-line tasks such as the one used by Rychlak et al. (1989) often give rise to strategic effects and thus are not a good measure of how semantic relations are represented. By this it is meant that the above study was concerned with the acquisition of synonymic and antonymic concepts and it is not clear if these results would generalize to reaction time (RT) studies. In RT studies information about the processing and relative ease of processing of the items involved can be determined.

The study by Herrmann, Chaffin, Conti, Peters, and Robbins (1979) made direct comparisons between the comprehension of synonymic and antonymic relations. The third experiment in their study, for example, looked at response time differences between synonym relatedness judgments and antonym relatedness judgments. All participants viewed pairs of words that fell into one of the following five categories: antonyms (good-bad), synonyms (fine-excellent), pseudoantonyms (popular-shy), pseudosynonyms (slow-late) and unrelated words (physical-legal). The participants were asked to either judge the pairs as being antonyms or synonyms; all participants saw the exact same pairs and differed only in the type of judgment they made. Different groups of participants were assigned to each of the judgment groups. They found no significant difference in the response times to synonym and antonym pairs. One problem with this experiment was that it compared response times from two different tasks (one requiring participants to explicitly look for a synonymic relationship and the other in which they were looking for an antonymic relationship), each possibly requiring qualitatively different processing strategies. Yes and no responses were also contrasted. Response times to indicate that two words were not antonyms (a no response) were compared to the response times in the other task to judge items as synonyms (a yes response). This was done to provide additional evidence concerning the effect of relationship similarity. This study would be improved if participants were making their decisions on the

synonyms and antonyms in one task in which both relationships required the same response. This would allow the relationships to be compared in a more direct fashion.

Examining the synonymic and antonymic associations among words in semantic "networks" could provide new evidence for the effects of particular semantic relations on the processing and representation of linguistic information. By assuming that different semantic relations were processed differently, processing differences (between, for example, synonyms and antonyms) could be examined and compared. This would allow a thorough investigation of all types of semantic relations, resulting in a determination of whether all relation types should be analyzed as a homogenous group. Experiments that analyzed all types of relationships together used items that were shown to have high association norms (as in the semantic priming experiments of Den Heyer, et al., 1985). These experiments were then taken to provide implications for models of word recognition. If semantic relations were studied in a manner such that they could be directly compared to each other, then the following could be determined:

(1) Whether different semantic relations show processing differences.

(2) Whether there are semantic relations (such as synonymy and antonymy) that are biased to receive preferential treatment.

Another factor that could be added to the above-mentioned studies is the internal morphologically complexity of items. In all the above

studies, semantic relations were treated as homogenous, without taking differences in morphological complexity into account. In the next section I discuss the issue of lexical processing of suffixed items, which will be a factor in my experiments, and how this morphological processing may interact with the processing of semantic relationships.

2.3 The Role of Suffixation

This section explores the possible effects of suffixation on the lexical relations of synonymy and antonymy. The bulk of the literature on suffixed words has been devoted to the investigation of how words that are morphologically simple (e.g., friend) are linked or related to their associated suffixed counterparts (e.g., friendly). One possibility is that simple words (e.g., friend) are simply connected via a compositional algorithm to some representation of (derivational) morphemes (in this example -ly) and that the complex word (e.g., friendly) is formed via word formation rules (Marslen-Wilson, et al, 1994). An alternative might be that both the simple and complex words are fully represented within the mental lexicon, such that the word friend would be linked to the complex word friendly. According to this view, the presentation of a word causes activation of other fully listed morphologically related items (Fowler, Napps, and Feldman, 1985). If this were the case, morphological priming effects could be equated with semantic priming effects. Thus, just as the words happy and sad are linked via the relation of antonymy, the words friend and friendly would be linked through a relation that links nouns to

their adjectival counterparts, and not through a morphological link that connects the word friend to the suffix -ly. However, when studying words that are semantically as well as morphologically related, there are other intervening factors. Two such factors are (1) a high degree of orthographic and phonetic overlap and (2) the existence of regular meaning changes associated with affixation.

The present study explores the effect of suffixation on the strength of relatedness among lexical items. The experiments presented in this study look at semantic relations and whether aspects of these relations among words are altered when suffixes are added to one or both items in the pair. In order to study this effect without any complicating factors, it was necessary to use affixes that were neutral with respect to the synonymic and antonymic relations. For example, the antonym pair happy-unhappy was not used because the affix un- provides the antonymic element that reverses the meaning of the root. Another example of disallowed affixes is represented by the pair careful-careless, in which the antonymic relation is a product of the suffixes -ful and -less and not of the semantic relationship between the roots themselves. An example of an allowed pair that contained suffixation on both items can be seen in the antonymic pair bravery-cowardice.

Imposing restrictions on the type of suffixation used allows for a direct examination of the interaction between semantic relationships and complex lexical items. Possible mechanisms for this interaction include

the following: If semantic links are anchored to lexical roots, then a stripping mechanism of the affixes would be required for semantic relations to be processed. The presence of a stripping mechanism would mean that the only difference between words with affixes and those without would be the extra processing time needed to strip the suffixed items of their affixes.

If, on the other hand, affixes did not need to be stripped in order for the semantic relationship to be recognized and processed, then lexical complexity could result in the need for processing that is different from the affix-stripping process. This different type of processing could result in the relations of synonymy and antonymy being affected differently by lexical complexity. The basic question with respect to suffixation is whether adding suffixes to the synonyms and antonyms result in a different type and strength of relationship. It could well be the case that suffixed synonyms and antonyms behave differently than non-suffixed synonyms and antonyms. If, for instance, the semantic relationship among items is the crucial relation for connectivity within the mental lexicon, then adding morphological complexity to the equation may complicate the basic semantic relation, resulting in the need for more processing time for the relationship to be recognized. It is also possible that this effect may only occur for either synonyms or antonyms, but not both.

2.4 Summary

In this chapter a description of the semantic relations of synonymy and antonymy was provided. The sub-types of the relations were outlined and examples of each were given. The section on synonymy and antonymy was concluded by introducing some of the studies in the literature that have focused on these relations. In general, there is a lack of processing studies that directly compare the on-line processing of synonyms and antonyms. Possible effects of suffixation on synonymic and antonymic pairs were discussed and the need for an investigation of semantic relations controlling for suffixation was expressed. The next chapter outlines the criteria used in the establishment of target synonymic and antonymic pairs employed in this study. In addition, the criteria used to establish suffixation as a control factor for these experiments is discussed, and the off-line rating pretest used to finalize target stimulus pairs is also described.

3. Development of Materials

3.1 Introduction

This chapter focuses on the creation of the stimulus list used in the experiments reported in this study. I first discuss the stimulus selection criteria for both monomorphemic and suffixed synonyms and antonyms. This is followed by a report of the synonym and antonym rating task that resulted in the creation of the stimulus list presented in Section 3.4.

As has been discussed in Chapters 1 and 2, the goal of the thesis is to investigate psycholinguistic aspects of synonym and antonym processing and their interaction with morphological complexity. In constructing synonym and antonym pairs, I chose to use a broad sampling of the synonym and antonym types discussed in Section 2.2. Morphological complexity was included as a factor by selecting synonymic and antonymic pairs in which each item in the pair was either morphologically simple (S) or morphologically complex (C). A morphologically simple lexical item is a word to which no suffix has been added, whereas morphologically complex words do have suffixes.

3.2 Selection Criteria

The factors of semantic relatedness (synonymy and antonymy) and the presence or absence of suffixation yield eight categories of word pair types. Each pair is related in terms of either synonymy or antonymy, as well as by type of morphological complexity. The first item in the pair is either S(imple) or C(omplex) and the second item in the pair is also S or C. These pairings result in the eight categories depicted in Table 3-1 below:

Table 3-1: The breakdown of morphological complexity for each stimulus pair in both the synonymic and antonymic relations.

Synonyms	Antonyms
simple-simple	simple-simple
simple-complex	simple-complex
complex-simple	complex-simple
complex-complex	complex-complex

Roget's Thesaurus (1977) and the Webster's Canadian English Dictionary (1988) were used to create a candidate pool of synonym and antonym pairs for each category. In the creation of this initial candidate pool, infrequent items were avoided, as were repetitions of roots in both the synonym and antonym categories. For morphological complexity, the following criteria were used: no prefixed items (i.e., no instances of happy-unhappy) and no suffixes that reversed the meaning of the word in antonym pairs (i.e., no instances of careful-careless) were included. This

resulted in the antonym pairs being lexical opposites and not morphological opposites. This alleviates the problem of orthographic and phonetic overlap. As far as possible, the complex-complex pairs also did not contain the same suffixes. None of the pairs was a compound and the base of each complex form had to be able to stand alone and had to have the same meaning standing alone as it did in its suffixed form. This distinction can be seen in a comparison of the words government and department: the govern in government maintains its meaning when the word stands alone, while the depart in department has a different meaning (i.e., department does not refer to a place or ideal in which someone departs). Examples of the types of pairs included in each category are provided in Table 3-2 below.

Table 3-2: Stimulus examples for each category of semantic relatedness and suffixation.

Category	Synonymy	Antonymy
simple-simple	big-large	fresh-stale
simple-complex	fast-speedy	greed-generosity
complex-simple	faithful-loyal	dangerous-safe
complex-complex	gratitude-appreciation	dryness-moisture

Following these criteria, 12 pairs were created for each category (see Appendix A). A group of association norm pairs were also added as controls. These pairs, chosen from the Palermo and Jenkins (1967) norms,

were given an average rating of at least 100 points (when the female and male response norms were considered together). These items and their normed association ratings are listed in Appendix B.

3.3 Synonym and Antonym Rating Task

The purpose of this rating task was to obtain an off-line measure of individual ratings for the strength of the meaning relationship for each of the synonym and antonym pairs. This was done to ensure that participants viewed the stimulus pairs as being strongly related by synonymy or antonymy and to allow a statistical check (a correlation analysis) of the findings obtained in this task against response time patterns in both of the on-line experiments. By obtaining these ratings it was possible to ensure that any reaction times obtained in the two on-line experiments were not due to the fact that subjects were preferring one group of stimulus items over another solely because those items were better representatives of their category. The ratings were also used to obtain mean relatedness judgments for each group of stimulus pairs. Some of the items were subsequently discarded, in order to obtain synonym and antonym pairs that were as equal as possible in their degree of relatedness within their respective morphological complexity categories.

Due to the nature of suffixed words (as morphemes are added something in their meaning component also changes), it was assumed that any category containing at least one complex item would receive

lower similarity rating judgments. However, it was also expected that this decrease in similarity for complex items would be the same for both semantic relations.

3.3.1 Participants

Nineteen participants volunteered for this task. All participants were native speakers of North American English between the ages of 18 and 30. All participants had completed high school. None of the participants had taken any linguistics courses.

3.3.2 Materials

The critical items were the 88 stimulus pairs described in section 3.2. Control items included the 50 association norm pairs from Palermo and Jenkins (1967) also described above in section 3.2 and presented in Appendix B.

3.3.3 Procedure

The synonym and antonym pairs were rated in separate questionnaires. Each questionnaire contained the synonym pairs (or the antonym pairs) and 25 of the control pairs. Each participant was given both questionnaires to complete. The order for completing each of the questionnaires was random. Participants were asked to rate the pairs of words according to how well the pairs represented a synonymic (or antonymic) relationship. Each stimulus pair was rated on a scale of 1 to 5. A response of 1 indicated that the participant thought the words

represented very poor synonyms (or antonyms) and a score of 5 indicated that the words were considered to be very good synonyms (or antonyms). The participants were asked to use the entire scale in their ratings.

3.3.4 Results

The first step in the analysis was to obtain mean averages for each of the synonym and antonym pair categories. The S-C and C-S groups (for both the synonym and antonym pairs) were analyzed together. This was done because, depending on the order of item presentation during the on-line tasks, each of these pairs would fit into both groups (S-C and C-S). For example, an S-C pair fast-speedy would be reversed to become the C-S pair speedy-fast. Table 3-3 below shows the averages for the participant ratings for each stimulus category:

Table 3-3: Average score for each category (all data) in the rating task. Ratings ranged from 1 (worst) to 5 (best).

Category	Synonyms	Antonyms
simple-simple	4.311	4.750
simple-complex & complex-simple	4.089	4.329
complex-complex	4.031	4.502

As can be seen in Table 3-3, all stimulus pairs were rated very high in all categories. It can also be seen that the antonyms seem to hold an advantage over synonyms in terms of average ratings. This was supported

by a two-way repeated measures ANOVA performed on the participants' rating scores for each pair. The two factors analyzed were semantic relationship (synonymy and antonymy) and morphological complexity (S-S, S-C, and C-C). There was a significant main effect of semantic relationship ($F(1,18)=33.072$, $p=.0001$), with the antonyms (rating of 4.527) showing a significantly higher overall rating when compared with the synonyms (rating of 4.144). The main effect of morphological complexity was also significant ($F(2,36)=24.964$, $p=.0001$), with pairs with the S-S pairs obtaining the highest ratings and the C-C pairs obtaining the lowest ratings. The interaction of semantic relation and morphological complexity was also significant ($F(2,36)=4.251$, $p=.022$), with antonyms showing a rating advantage at all levels of morphological complexity.

In an attempt to put the synonym and antonym pairs on a more equal footing, the two best antonym pairs and the two worst synonym pairs were discarded from each category. The resulting group ratings are shown in Table 3-4 below.

Table 3-4: Average ratings in each of the six categories of morphological complexity after exclusion of the two worst synonyms and the two best antonyms.

Category	Synonyms	Antonyms
simple-simple	4.389	4.711
simple-complex & complex-simple	4.252	4.318
complex-complex	4.158	4.442

A two-way repeated measures ANOVA was then performed on the participants' averages in each of the six stimuli categories (now with ten pairs in each group). As in the non-trimmed analysis, though, significance was still found in both main effects and in the interaction.

Planned comparisons for the trimmed data, which tested the synonyms and antonyms at each level of complexity, revealed that the significant interaction was due to significantly higher ratings for the antonym pairs as compared to the synonyms both in the S-S group [$F(1,36)=25.525$, $p=.0001$) and the C-C group [$F(1,36)=20.003$, $p=.0001$]. There was no significant rating difference between the synonyms and antonyms for the S-C/C-S group.

3.3.5 Discussion

The results of this rating task indicate that, for the stimulus pairs, the antonyms displayed higher overall ratings for each level of suffixation

when compared to the synonym pairs. This could result in antonyms showing a processing advantage in the on-line experiments (a relatedness judgment task and a semantic priming task), and it is therefore important to take this into consideration when drawing conclusions from the results found in the on-line tasks. If the antonyms exhibit a similar processing advantage for the on-line tasks as in this rating task, it could simply be that they are easier to process because they are more strongly related than the pairs of synonyms. In order to ensure that any results found in the on-line tasks are not due to the antonymic rating advantage, the rating results from this experiment will be used as a baseline measure in a correlational comparison with the response time patterns from the on-line tasks.

One possibility for why the antonyms consistently received higher average ratings across all levels of morphological complexity could be due to the fact that these words are judged based on "opposition", which is perhaps an easier relation to directly identify than the relation of similarity. This supports the literature on the semantics of lexical relations discussed in Section 2.2, in which it was noted that antonyms are opposed along only one dimension of meaning, while true synonyms must have the same usage in all instances.

3.4 Final Stimulus List

Based on the criteria discussed in Section 3.2 and the results of the off-line rating task, the final stimulus list was compiled. Table 3-5 shows a complete listing of all the stimulus pairs. All items in each category are

reversible. However, it should be noted that items in the simple-complex and complex-simple categories switch categories when their reverse order is used. Thus, twenty pairs are used in each level of morphological complexity for each semantic relation. Appendix C lists the ratings for each pair of synonyms included in the final stimulus list. The ratings for each of the antonym pairs can be found in Appendix D.

Table 3-5: Final stimulus pairs for both semantic relations across each level of morphological complexity.

Category	Synonymy	Antonymy
simple-simple	garbage-trash	old-young
	couch-sofa	urban-rural
	large-big	correct-wrong
	grief-sorrow	fresh-stale
	stiff-rigid	far-near
	destroy-ruin	end-start
	close-shut	dark-light
	cash-money	strong-weak
	burn-scorch	always-never
	buy-purchase	hot-cold
simple-complex	change-alteration	ugly-beautiful
	fast-speedy	copy-original
	deliberate-intentional	grace-awkwardness
	novice-beginner	whole-divided
	jealous-envious	faith-skepticism
	mute-voiceless	flat-bumpy
	brief-momentary	bend-straighten
	slick-slippery	simple-complicated
	appear-materialize	guilt-innocence
	test-examination	safe-dangerous
complex-simple	peaceful-serene	expensive-cheap
	deadly-fatal	ethical-corrupt
	collision-crash	conceited-modest
	verification-proof	generosity-greed
	breakable-fragile	fictitious-real
	alternative-choice	contaminated-pure
	faithful-loyal	agitated-calm
	astonishment-shock	healthy-sick
	wonderful-great	lower-raise
	wealthy-rich	domesticated-wild
complex-complex	funny-humourous	angelic-demonic
	sickness-illness	cautious-daring
	annoying-bothersome	clearly-vaguely
	cheerfully-happily	talkative-speechless
	sleepy-tired	solidify-liquify
	appreciation-gratitude	required-optional
	active-lively	attractive-repulsive
	reduction-shrinkage	bravery-cowardice
	increasing-expanding	dryness-moisture
	lateness-tardiness	addition-subtraction

4. Experiment 1: Relatedness Judgment Task

4.1 Introduction

The pretest reported in Section 3.3 suggested that antonyms may be easier to process than synonyms. This suggestion is based on the fact that they received higher average ratings than the synonymic pairs. One problem with the task was that participants were rating synonyms on how good they were as synonyms and were rating antonyms on how good they were as antonyms. Thus, the question asked of each relationship was different. It is possible, however, that if they were being judged (or responded to) on an equal footing, then more about the actual mental processing of synonymy and antonymy could be determined. In particular, this approach would allow responses for each relationship to be more fairly compared. Another problem with the rating task was that no time limits were imposed, as participants could return the questionnaires whenever they had completed filling them out. This allowed participants to use metalinguistic knowledge concerning their beliefs about the words' meanings and general world knowledge associated with the items under investigation. If an on-line task were employed, participants would be forced to make the decision based solely on their knowledge of the pairs

and would not have time to consider general world knowledge information connected to these items.

The objective of this first experiment was to investigate explicit on-line processing of semantic relations. In order to allow for the direct comparison of synonymic and antonymic processing, participants were asked to judge whether two lexical items, presented simultaneously on a computer screen, were related to each other or not. This allowed both the synonymically related items and the antonymically related items to receive a yes response. This paradigm ensured that the two relations were addressed in the same task and also that they were processed in the same manner.

This first experiment was also designed to explore the explicit processing of synonyms and antonyms (to be compared with the results from the implicit processing task in Experiment 2). This relatedness judgment task taps explicit processing in that subjects were told to determine if pairs of words were related to each other or not by actually thinking about the relationship among items presented to them. In other words, the participants had to consciously think about whether the two items were in some way related to each other before making a yes or no decision. This experiment also allowed for a comparison of synonymic and antonymic processing across differing levels of morphological complexity.

It was expected that no difference would be found between synonymous and antonymous pairs in the second experiment. It was also expected that a significant main effect of morphological complexity would be found. This was expected because the addition of suffixes lengthens the words in the experimental pairs and likely increases the reading time for the participant.

It may also be the case that suffixation results in the need for extra processing above and beyond that required for the extra length of the lexical items. If this is the case, then, it may be expected that processing of antonymic relations containing suffixes would be more difficult than their synonymic counterparts. An antonymic pair containing suffixation (e.g., talkative-speechless) may have one item that contains a suffix that, although does not change the meaning of its root (the speech in speechless refers to the same thing in both lexical items), it does reverse the meaning intended by the root (for example, in the pair luck-luckless, the second word can be construed as meaning 'without luck') . These types of suffixes can be viewed as neutral in that the items are not solely suffixed opposites of each other (which is the case in a pair such as careful-careless). However, in these cases the suffix does reverse the meaning of its root and may result in an extra processing load for antonymic pairs. This reversal is not seen in complex items within synonymous pairs. In C-C synonym pairs (e.g., funny-humourous), the suffixes simply add to the meaning of the root without reversing its meaning.

Thus, it is expected that an interaction effect will be found between the factors of semantic relation and morphological complexity. By this it is meant that differences between synonymic and antonymic processing is only expected once the factor of morphological complexity is included.

4.2 *Method*

4.2.1 Participants

Thirty-six participants volunteered for this experiment. The participants were all native speakers of English drawn from the volunteer subject pool in the department of linguistics at the University of Alberta. All participants had completed an introductory linguistics course. None of the participants had performed the pretest rating task.

4.2.2 Materials

The core experimental materials (the synonym and antonym pairs) used in this task were the 40 synonym pairs and 40 antonym pairs discussed in Chapter 3 and presented in Table 3-5. In addition to the experimental materials, another 40 related pairs were included. These pairs were taken from the Palermo and Jenkins (1967) association norms as discussed in Section 3.2. To complete the stimulus items, 120 non-related pairs were used as experimental foils. These foils (e.g., snore-album) were included to ensure that participants were producing a comparable number of no responses and yes responses. The entire stimulus set used in Experiment 1 is summarized in Table 4-1.

Table 4-1: Summary of the numbers of pairs for each type of relation included in the experiment and their correct response.

pair relation	number of pairs	correct response
synonymic	40	yes
antonymic	40	yes
associated	40	yes
non-associated	120	no
TOTAL	240	

4.2.3 Procedure

Participant testing took place in the morphology laboratory at the University of Alberta during one session of approximately 20 minutes in length for each participant. To begin the session all participants signed a written consent form and then read instructions that were presented on the computer screen. Some verbal instructions were also given to complement the written instructions. Included in these verbal instructions was an emphasis on the necessity of participants to respond as quickly and as accurately as possible in each trial of the experiment. The participants were told that two words would appear simultaneously on the computer screen. The task was to indicate if the words were related to each other in some way by pressing either a button labeled yes or a button labeled no. Participants were not informed of the types of relationships that would appear among the items in the word pairs. All participants

were also told that some errors invariably occur in this task, so they should not dwell on any mistakes they made but just proceed as quickly as possible to the next pair. Participants were told that the time it took them to respond to items was an important factor in the success of the experiment.

The experiment was set up using three experimental blocks. The first block represented a practice session in which participants saw ten practice trials, after which they were allowed to ask for more instruction if they felt it was necessary. The second block was a further practice session not identified as such to the participants, who were informed that the actual experiment began at the end of the first block. This second block contained six trials and was used so that the first actual experimental trials would then contain usable response times. The third block, then, made up the actual experimental part of the task in which both response time and accuracy was measured. This block contained 240 trials.

For each trial of the experiment, the participant would see the following displays. First a fixation point (*) was presented for 500 milliseconds. This was followed by the presentation of the stimulus pair (either a synonym pair, an antonym pair, an associated pair, or an unrelated pair) on the screen. The stimulus pairs remained on the computer screen until the participant produced a yes or no by pressing one of two colour coded keys on the keyboard. This key press triggered the presentation of the next trial.

Stimulus presentation and data acquisition were controlled by a PsyScope script (Cohen, MacWhinney, Flatt, and Provost, 1994). Two versions of this experiment were created. The difference between the two versions was that the order of the items within the synonym and antonym pairs was reversed. This resulted in pairs that were "simple-complex" (e.g., greed-generosity) in one version and were "complex-simple" (e.g., generosity-greed in the other version.

4.3 Results

The scores of four participants were excluded from analysis due to high error rates. These four participants appeared to misunderstand the task as they responded no to over 90% of antonymous pairs. The data for the other participants indicated that they were responding at a minimum accuracy level of 96%. Because of the high rate of accuracy, this dependent variable was not analyzed. Results reported are thus for response time means trimmed to two standard deviations above and below each participants' mean response time. This technique was used to eliminate any outlying data points, as well as to preserve the information that the data point was an extreme value.

The first statistical test that was performed was a one-way repeated measures ANOVA, with semantic relationship as the repeated measure.[1] In this test, all pairs of synonyms and antonyms were collapsed across all

[1] Since the associated pairs were not controlled for suffixation, associated pairs could only be compared to the synonyms and antonyms collapsed over levels of suffixation.

levels of morphological complexity. A significant effect of semantic relationship was found ($F(2,62)=51.914$, $p=.0001$) The means for each of the three semantic relationships analyzed can be seen in Table 4-2:

Table 4-2: Mean response times (and standard deviation) in milliseconds for each semantic relationship averaged over level of morphological complexity.

Category	Example	mean	standard deviation
synonyms	couch-sofa	1264.778	251.370
antonyms	happy-sad	1241.051	199.800
associations	blue-sky	1076.268	143.511

Planned comparisons indicated that the significant effect was due to the significantly faster response times to the associated items than to the synonym and antonym pairs ($F(1,62)=102.442$, $p=.0001$). As expected, no significant difference was found between the response times to the synonyms and antonyms ($F(1,62)=1.386$, $p=.2436$).

The second statistical test was a two-way repeated measures design that compared the semantic relationships of synonymy and antonymy across the three levels of morphological complexity.[2] No significant differences for the main effect of semantic relation were found between the synonyms and antonyms ($F(1,31)=1.922$, $p=.1755$).

[2] The associated pairs could not be included in this analysis as they were not controlled for level of suffixation.

As expected, a significant main effect of morphological complexity was found ($F(3,93)=39.554$, $p=.0001$). The source of this effect can be seen in Table 4-3 where the "simple-simple" pairs show the fastest response times.

Table 4-3: Mean response times (and standard deviations) in milliseconds for each level of suffixation, averaging over levels of semantic relation.

Category	Example	mean	standard deviation
simple-simple	cash-money	1089.568	224.254
simple-complex	safe-dangerous	1272.799	242.811
complex-simple	collision-crash	1310.635	256.350
complex-complex	clearly-vaguely	1338.656	294.878

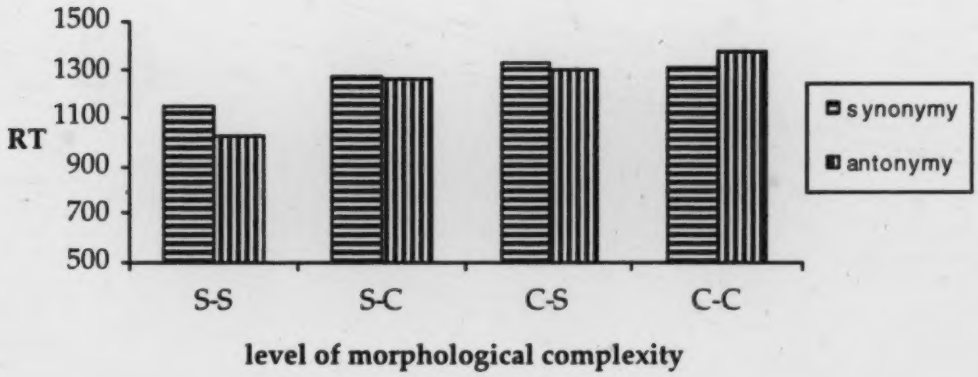
Planned comparisons indicated that the significant main effect of morphological complexity existed only between the "simple-simple" pairs and all of the other three levels of morphological complexity ($F(1,93)=111.799$, $p=.0001$), with no significant differences between any of the three morphologically complex types.

A significant interaction of semantic relatedness and morphological complexity was also found ($F(3,93)=5.899$, $p=.001$). The category means for the interaction are presented below in Table 4-4 and are presented graphically in Figure 4-1.

Table 4-4: Mean response times and standard deviation (presented in brackets) for each level of the interaction of semantic relationship and suffixation.

Category	Synonymy	Antonymy
Simple-Simple	1151.887 (241.250)	1027.250 (189.691)
Simple-Complex	1278.026 (282.358)	1267.572 (200.083)
Complex-Simple	1321.918 (284.206)	1299.351 (229.161)
Complex-Complex	1307.279 (298.946)	1370.033 (292.079)

Figure 4-1: Mean response times (in milliseconds) for each category of the interaction.



From the above figure, an interesting trend can be seen. It appears that at the "simple-simple" level of morphological complexity, the antonymous

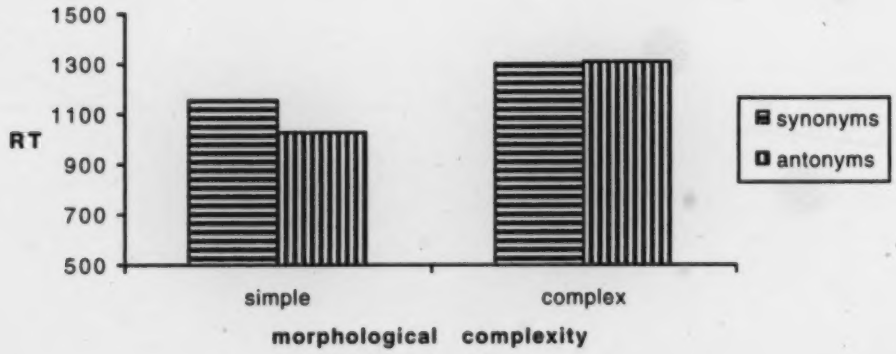
pairs are easier to process than the synonymous pairs, while this pattern is reversed for the "complex-complex" level. To see if any significant differences were present, synonyms and antonyms were compared within each of the four levels of morphological complexity. For example, the S-S synonyms were compared to the S-S antonyms. This analysis resulted in only one significant comparison. This significant difference was between synonyms and antonyms at the S-S level of morphological complexity ($F(1,93)=15.411$, $p=.0002$) in which it was found that antonyms were responded to more quickly. The comparison of C-C synonyms and antonyms showed a trend toward significance in the opposite direction as that found between these semantic relations at the S-S level, with synonyms being responded to more quickly than antonyms. However, this difference did not reach significance ($F(1,93)=3.907$, $p=.0511$).

The data in this experiment were also analyzed in an items analysis. This was done to ensure that results for any one category were not simply due to anomalies within a particular stimulus category. The items were analyzed in a one-way between-items design in which the items were classified into one of nine categories: the four levels of morphological category for each of the synonymic and antonymic categories and one category for the associated item pairs. A significant effect of category was found ($F(8, 224)=13.497$, $p=.0001$). Post hoc comparisons of synonyms and antonyms within each category of morphological complexity resulted in only one significant finding. Using the Fischer's Protected LSD test a

significant difference was only found between the S-S antonymous items and the S-S synonymous items.[3]

To summarize, the response time results indicated a processing advantage for antonyms over synonyms for morphologically simple pairs but not among pairs which contained one or more suffixed stimulus. This pattern is represented in Figure 4-2 below.

Figure 2: Mean responses (in milliseconds) comparing synonymic and antonymic relations in which both items of the pair are morphologically simple to pairs in which at least one item is morphologically complex.



A correlation analysis was performed between the response times, averaged for each stimulus pair, and the mean ratings from the pretest. Response times and ratings showed a significant negative correlation using the Pearson's correlation coefficient (r=-.4933, p<.0001). This significant negative correlation represents a congruence between the pretest and the relatedness judgment task.

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[3] Even though the least stringent post-hoc test was used, there was still only significance found between two of the categories.

4.4 Discussion

Fundamentally, this relatedness judgment experiment can be considered to be an on-line replication of the off-line rating task. Like the pretest, this on-line experiment gathers information about participants' judgments concerning the relatedness of certain pairs of synonyms and antonyms. The difference between the tasks is that the on-line version allows the synonyms and antonyms to be judged in the same manner. The off-line task rated the synonyms and antonyms on separate terms, while the on-line task used a common rating scheme. The response time measure of Experiment 1 can be seen as replacing the 5-point judgment scale used in the pretest. This task improves upon the pretest in that not as many of the external factors discussed in Section 4.1 affect the judgments. The response time "ratings", therefore, provide a less biased dependent variable.

The results suggest that the two tasks generally yield converging evidence. This conclusion is supported by the highly significant correlation between the two sets of scores and by the finding that antonyms show a processing advantage for the S-S level in both tasks, with no significant difference between the synonyms and antonyms at the other levels of morphological complexity.

The results for the C-C pairs seem to also support the claim that the two tasks are essentially probing the same phenomenon. However, in the on-line task, the synonyms were judged more quickly, while in the off-

line task the antonyms were rated more highly. These differences between the synonyms and antonyms were roughly in the same proportion but in opposite directions. In both cases probabilities approached, but did not reach, significance.

The results indicate that the processing of synonymy and antonymy is not as clear-cut as is described in the literature. The literature suggested that no difference exists between these relations and that they could be treated as a homogenous group for the purpose of processing studies. In Experiment 1, although the finding of no processing differences between synonyms and antonyms for the main effect of semantic relationship supports the earlier work by Hermann, et al., (1979), the significant interaction between semantic relationship and suffixation suggests that this straightforward assertion is not tenable once synonyms and antonyms are compared at differing levels of morphological complexity. This finding of an interaction between semantics and suffixation presents a challenge for current theories of lexical processing that consider both these factors to have an additive rather than an interactive effect on lexical processing. Experiment 1 suggests that each factor has a separate and different effect on the relationship's links and strengths.

The observed trend of a reversal in processing times for synonyms and antonyms at the S-S and C-C levels of morphological complexity is difficult to explain. A partial explanation for this finding could be that, at the S-S level, the antonym pairs were more highly rated in the pretest.

However, this account would predict that the same pattern would be found among pairs containing complex items, if antonyms were more highly rated than synonyms for all levels of morphological complexity. In fact, however, no overall difference was found between the synonymic and antonymic pairs once at least one complex item was added. This explanation, therefore, fails to account for all levels of morphological complexity.

In my view a more plausible explanation would also take into account other factors. I propose that the pattern of results found represent three effects. These three effects are:

(1) An interaction of required response types (yes) and type of semantic relation.

(2) The synonymic and antonymic rating results as shown in the pretest.

(3) The strength of association among items in semantically related pairs.

The first effect refers to a mismatch between required response type (yes) and the type of lexical relation being processed. For synonyms, in which the relationship is essentially positive, the correct "yes" response is congruent with the nature of the semantic relation. The antonyms, on the other hand, represent essentially a "negative" relationship. Thus, the correct "yes" response is incongruent with the nature of the semantic relation. It is clear that this factor could not be the only one influencing the on-line response times. If it were, it would then be expected that the antonyms would have shown a disadvantage at all levels of

morphological complexity, which was clearly not the case. This effect mostly provides an explanation for why, at the C-C level, the synonyms obtained the processing advantage. It is possible that this mismatch comes into play once more processing time has elapsed (which is what occurs for the C-C levels as they contain longer words and thus require more time for recognition to occur).

The second effect deals with the antonymic advantage displayed at all levels of morphological complexity in the rating pretest. Again this does not account for the full pattern of responses, but the antonymic advantage displayed in the pretest seems to be rendered neutral by the antonymic disadvantage from the mismatch of the first effect. Basically this is saying that one factor benefits the synonymic relationship while the other benefits the antonymic advantage.

The first two effects account for the absence of significant differences between synonyms and antonyms whenever a complex item is involved and also provides an account for the synonymic advantage at the C-C level. Now, all that is left to explain is the antonymic advantage displayed for the S-S pairs. It is for these pairs that the third effect concerning amount of association among items in semantically related pairs comes into play. The S-S antonyms selected for this study were not only significantly more highly rated than their synonymic counterparts but also seem to be more highly associated to each other in terms of co-occurrence, as shown in normed associations and word generation tasks. The

antonymous pairs are also more often seen together in contrastive senses. Thus, it is not just an accident that the antonyms are more quickly judged as being related. This effect can be seen by looking at the S-S pairs used for each relation and represented in Table 4-5 below.

Table 4-5: The stimulus pairs used for each semantic relation at the S-S level.

Category	Synonymy	Antonymy
Simple-Simple	garbage-trash couch-sofa large-big grief-sorrow stiff-rigid destroy-ruin close-shut cash-money burn-scorch buy-purchase	old-young urban-rural correct-wrong fresh-stale far-near end-start dark-light strong-weak always-never hot-cold

In summary, Experiment 1 replicated the findings of the pretest with the exception of the C-C level of morphological complexity, where the reverse trend was found. This significant interaction of semantic relationship and morphological complexity suggests the possibility of fundamental differences between synonymic and antonymic relations. If the basic relations of synonymy and antonymy were the same, then adding neutral suffixes to either item in such relationships should not have made a difference. In order to further investigate this processing difference exhibited between synonyms and antonyms it was necessary to see how these relations were processed in a different task. It may be the case that the relatedness judgment task, being more sensitive than the rating

pretest, picks up some differences that are due to the on-line nature of the task. In the next chapter, a task that probes on-line implicit processing is used to further delineate the exact nature of the processing differences between these two semantic relations.

5. Experiment 2: Semantic Priming Task

5.1 Introduction

As reported in Chapter 4, experiment 1 was a task requiring the explicit processing of the semantic relations in question. Participants were required to consciously judge whether or not the presented stimulus pairs contained items that were related to each other. In order to do this, the participants were required to look for a possible relationship between the items in the pair and then make an explicit judgment as to the relatedness of the presented stimulus pair. Thus, the relatedness judgment task presented in Chapter 4 was an on-line task that required metalinguistic skills. Although this task was able to provide some information about existing differences between synonymic and antonymic processing, it is also necessary to look at any differences displayed between synonymy and antonymy during implicit processing. A task that requires implicit processing does not usually allow metalinguistic knowledge to be a factor. Thus, the objective of this second experiment was to investigate the implicit, on-line processing of synonymy and antonymy. By implicit processing, it is meant that participants were not made explicitly aware of any existing relationships among the linguistic input that they were being

asked to process. In this way, metalinguistic knowledge would not likely be a factor in response patterns.

One methodology that allows the desired implicit processing to be studied is the semantic priming paradigm. In priming paradigms participants see strings of letters to which they must respond by saying whether the letter string represents a word or not (a lexical decision). Participants typically respond more quickly that a string of letters is actually a word if that word has been preceded (or primed) by a related lexical item. Besides measuring the strength of association among lexical items, this type of task also measures the ability of lexical items to show a spread of activation to related items. Priming tasks can provide information about the activation threshold of individual lexical items and how this threshold changes when words are primed by related items. In this type of task, participants are asked to perform lexical decisions on presented stimulus items without having to comprehend (and preferably not notice) that a relationship exists between some of the items that are presented. In a paired lexical decision task where participants are only making lexical decisions on targets, some of the implicitness of the task is lost, as participants know that the prime and target are paired together in some way. On the other hand, in a priming paradigm using a straight lexical decision on both prime and target (as in the experiment described below), an explicit pairing of the items does not occur.

Although many priming experiments have been done that have looked at the priming ability of semantically and morphologically complex items, these studies have primarily focused on one or the other and not on an interaction of the factors (Marslen-Wilson, et al., 1994). Surprisingly, despite the fact that antonymy and synonymy represent fundamental semantic relations, no implicit processing study has looked at these relationships in a comparative manner. Thus, this experiment represents an exploratory investigation into this issue. The experiment presented here examined this interaction by using stimulus pairs that were only related by synonymy or antonymy. As an extra control for the morphological complexity of items used, pairs with suffixes on one or both items were placed in separate groups for analysis.

It was expected that no difference in response times to make lexical decisions would occur between items primed by synonyms and items primed by antonyms. This would support the findings from explicit tasks that have shown no difference between these relations. It should be noted that a processing difference was found between synonyms and antonyms at the S-S level in the present study. However, the priming paradigm differs in critical ways from the relatedness judgment paradigm used in Experiment 1. In the relatedness judgment task participants' attention was focused on the semantic association itself, while the priming task focuses on the result of that association by measuring the effect of one word's presentation on another. This feature introduces a crucial element of

control that was not available in the judgment task. The priming paradigm allows the response time to make a lexical decision on a word (e.g., happy) both when it is preceded by its semantically related prime (e.g., sad) and when it is preceded by a control item (e.g., computer). Thus, the same word is measured in two different conditions and serves as its own control.

Differences between these two experiments also suggests a different expected pattern of results for the main effect of suffixation. In the first experiment, the addition of suffixation was expected to cause any pairs with at least one complex item to take longer to process because both words appeared on the screen simultaneously, and a complex word would result in increased reading time. On the other hand, in the priming experiment, response times were only measured and analyzed for the targets which appeared on the screen alone. Thus, it was expected that quicker response times would occur for the pairs with the simple targets (i.e., the S-S and C-S pairs) as compared with pairs containing a complex target (i.e., the S-C and C-C pairs).

The above discussion is only relevant if priming does actually occur for semantically related items. Priming effects have been found throughout the literature for semantically related items. Thus, the prediction of a significant main effect of prime-target relationship serves as a test for the validity of the experimental procedure.

Finally, a significant interaction of semantics and morphological complexity was expected. This is because, as explained in Section 4.4, the greater processing load required for complex items will potentially allow the mismatch between the required response type (yes) and semantic relation to play a role. Thus, antonyms are expected to require extra processing time or to result in lower accuracy rates due to the mismatch of a required yes response to the "negative" relation.

5.2 Method

5.2.1 Participants

Sixty participants volunteered for this experiment. The participants were all native speakers of English drawn from the volunteer subject pool in the department of linguistics at the University of Alberta. All participants had completed an introductory linguistics course. None of the participants had performed the Relatedness Judgment Task of Experiment 1 or the pretest.

5.2.2 Materials

The core experimental materials (the synonym and antonym pairs) used in this task were, again, the stimulus pairs discussed in Chapter 3 (Table 3-5). Thus, 40 prime-target synonym pairs and 40 prime-target antonym pairs were used. To complete the experimental materials another ten related pairs were included. These pairs were drawn from the Palermo and Jenkins (1967) association norms (as discussed in Section 3.2).

The addition pairs resulted in 90 related prime-target pairs being used in the semantic priming task. As well, 90 non-word primes were paired with 90 non-word targets. So that not all non-word targets were followed by non-words, 50 non-word targets were preceded by real word primes and 40 real word targets were preceded by non-word primes. These prime-target pairs were compiled into four versions of the experiment. In each version, 280 prime-target pairs were used (100 related pairs and 180 non-related pairs). As well, each item in the related pair set was paired with a non-related control word matched for length and frequency. These items were then used as control primes for their related items. The versions were split up such that in each version there were five experimental pairs for each sub-category of experimental stimulus. For example, in any version there would be exactly five complex-complex experimental antonym pairs. As well, any pair not included in the experimental pairs would have one member of its related pair in that version along with a control prime. Thus, in any one of the experimental versions, 20 stimulus pairs were related by antonymy (five for each level of suffixation), 20 pairs related by synonymy (again, five for each level of suffixation), and five items of the associated pairs were included.

5.2.3 Procedure

Participant testing took place in the morphology laboratory at the University of Alberta during one session of approximately 20 minutes in

length for each participant. All participants signed a written informed consent form.

To begin the session, the participants read instructions that were presented on the computer screen. Some verbal instructions were also given to complement the written instructions. Included in these verbal instructions was an emphasis on the necessity for participants to respond as quickly as possible to each trial of the experiment. Once the experiment started the participant would see a fixation point followed by a word or a non-word appearing on a computer screen. For each word and non-word the participants had to decide if what they had seen represented a real English word. Participants were not told that specific relationships would occur between any of the items being presented to them. All participants, besides being instructed to answer as quickly as possible, were also instructed to answer as accurately as possible but not to worry if they felt they had made any errors and to proceed as quickly as possible to the following item.

The experiment contained three blocks of trials. The first block represented the practice session in which ten practice trials each containing a prime and target were presented. Following the practice session participants were allowed to request further instruction if necessary. The second block contained a further practice session that was attached directly to the experimental session. Participants were told after the initial block that the experiment was about to begin. This was done so

that participants were responding naturally to the first trials in the experimental block.

For each trial of the experiment the following events occurred. First, a fixation point (*) was presented (for 150 milliseconds) in the middle of the computer screen 250 milliseconds after the start of the trial. This was followed by presentation of the prime on the screen. The prime remained on the screen until a lexical decision (yes the item was a word of English or no it was not a word of English) had been made by the participant. This decision was registered by the appropriate key press which triggered the presentation of another fixation point 250 milliseconds after the prime had disappeared from the screen. This second fixation point was followed by the target item which also required the participant to make a lexical decision. The response to the target ended the current trial and triggered the beginning of the subsequent trial.

The stimulus presentation and the data collection were controlled by a PsyScope script (Cohen, et al., 1994). The differences between the four experimental versions were the order of presentation of the items within related pairs (e.g., happy-sad vs. sad-happy), as well as which pairs were used as experimental pairs and which were presented as control items in each (e.g., happy-sad vs. carry-sad).

5.3 Results

The data from all 60 participants were included in the analyses. For each participant, data points that were above or below two standard

deviations of each participants' mean response time to the experimental items were replaced by the upper or lower bound of that participants' response time. This technique was used to eliminate any outlying data points, as well as to preserve the information that the data point was an extreme value. Results reported for the subject analyses are on the response time means obtained from this data trimming procedure. It is response time means from the subject analyses that are reported in most of the tables and figures below.

The first statistical test performed was a three-way repeated measures ANOVA, with response time to targets as the dependent variable. The three within-subjects factors were semantic relation (synonymy and antonymy), suffixation (S-S, S-C, C-S, and C-C), and prime-target relationship (target preceded by a control item or an experimental item). An items analysis was also performed on the individual stimulus items used in the synonym and antonym pairs in the experiment. In this case the design was a three-way mixed ANOVA in which semantic relation and suffixation were the between-items factors and prime-target relationship was the within-items factor.

5.3.1 Main Effects

In both the subjects and items analyses the three main factors of the experiment yielded no significant main effect of semantic relationship ($F_{subj}(1,59)=.374$, $p_{subj}=.543$; $F_{item}(1,3)=2.092$, $p_{item}=.1501$) , but

significant effects of suffixation ($F_{subj}(3,177)=48.618$, $p_{subj}=.0001$; $F_{item}(3,152)=11.908$, $p_{item}<.0001$) and prime-target relationship ($F_{subj}(1,59)=10.055$, $p_{subj}=.0024$; $F_{item}(3,152)=4.269$, $p_{item}=.0405$) were found.

The mean response times and standard deviations that contributed to the significant main effect of suffixation can be seen in Table 5-1 below.

Table 5-1: Mean response times and standard deviations (in milliseconds) for each level of suffixation across all participants.

Category	Example	mean	standard deviation
simple-simple	large-big	618.990	114.978
simple-complex	copy-original	701.935	129.933
complex-simple	wealthy-rich	635.314	113.026
complex-complex	cautious-daring	671.347	116.938

As can be seen in Table 5-1, the response times pattern into two groups. One group contains pairs that have simple targets which were responded to more quickly than the other group which contains the pairs with the complex targets ($F(1,177)=124.678$, $p=.0001$).

The significant main effect of prime-target relationship resulted from the fact that response times to targets that were preceded by a control prime (664.688 msec) were slower than response times to targets preceded by semantically related primes (649.105 msec). As was discussed above,

this is a critical finding as it validates the experimental procedure and provides a framework for the interpretation of all other results.

Although no significant effect of semantic relation was found, the fact that there was a significant effect of prime-target relation shows that the lack of a difference between synonymy and antonymy indicates that both types of word pairs do result in the facilitation of their semantically related targets.

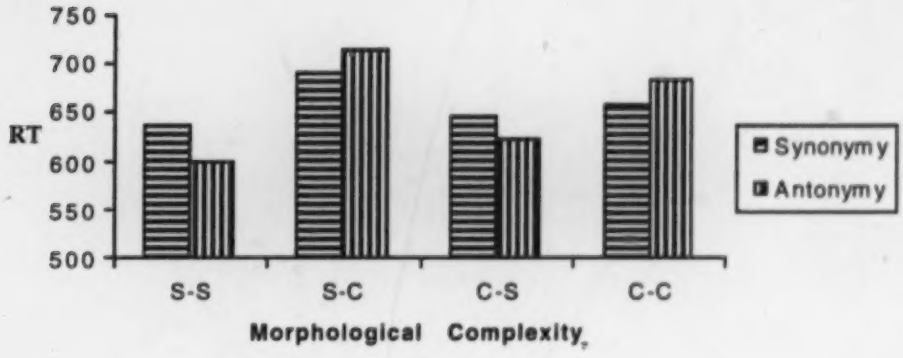
5.3.2 Interaction Effects

A significant interaction of semantic relationship and suffixation was found in both subjects and items analyses ($F_{subj}(3,177)=16.579$, $p_{subj}=.0001$; $F_{item}(3,152)=4.259$, $p_{item}=.0064$). The category means and the standard deviation for this interaction are presented below in Table 5-2 and presented graphically in Figure 5-1. The means that are represented indicate the average response times to targets, regardless of whether they were primed by a control or experimental item.

Table 5-2: Mean response times and standard deviations (in milliseconds) for each category of the interaction of semantic relationship and suffixation.

Category	Synonymy	Antonymy
Simple-Simple	639.493 (115.499)	598.488 (111.189)
Simple-Complex	689.715 (125.499)	714.154 (133.819)
Complex-Simple	646.225 (115.576)	624.403 (109.814)
Complex-Complex	658.182 (111.282)	684.511 (121.371)

Figure 5-1: Mean response times (represented in milliseconds along the y-axis) for each category of the interaction.



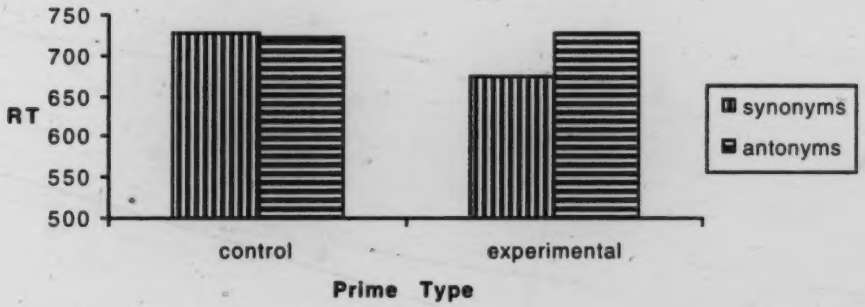
As was noted above for the main effect of suffixation and can be seen in the above figure, simple targets show faster response times. As can also be seen in Figure 5-1, the antonyms show faster response times than synonyms for all pairs which have simple targets. This difference was found to be significant in a planned comparison ($F(1,177)=28.772$, $p=.0001$). For pairs that contain complex targets the exact opposite was observed. This difference was also found to be significant in a planned comparison ($F(1,177)=18.787$, $p=.0001$).

No significant interaction was found between the two-way interaction of suffixation and prime-target relationship. Thus, the response time patterns across morphological complexity discussed above

were essentially the same for primed and unprimed stimuli, with the semantically primed targets showing faster response times.

The interaction of semantic relation and prime-target relationship resulted in a significant effect for the items analysis ($F_{item}(1,152)=7.029$, $p_{item}=.0089$), while the subjects analysis showed no significant effect ($F_{subj}(1,59)1.339$, $p_{subj}=.252$). Here, the response time patterns for the two figures are shown in Figure 5-2.

Figure 5-2: The response time patterns for the items analysis interaction of semantic relation and prime type.



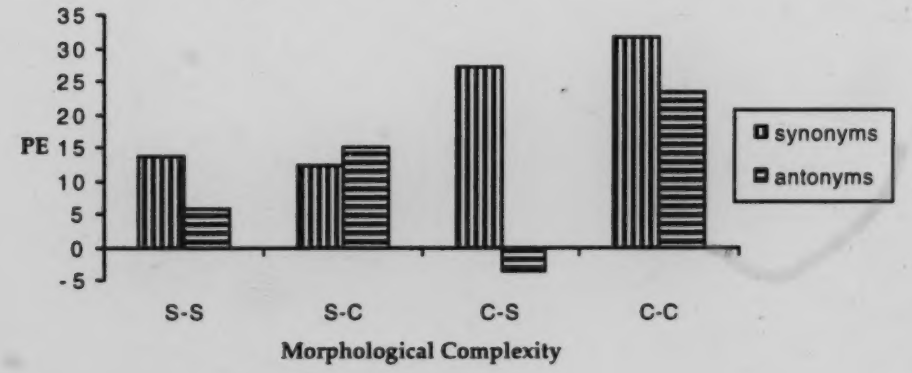
The three-way interaction of semantic relation, morphological complexity, and prime-target relation was not significant in either the subjects or items analyses ($F_{subj}(3,177)=.649$, $p_{subj}=.5846$; $F_{item}(3,152)=.662$, $p_{item}=.5765$). In order to more clearly display the effects, the raw response times were converted to "priming effects" which are calculated as the difference between neutrally primed targets and semantically primed targets. This three-way interaction can be seen in Table 5-3 below which represents the mean priming effects and standard

deviations for all categories. The pattern is also represented graphically in Figure 5-3.

Table 5-3: Mean priming effect and standard deviations (in milliseconds) for each category of the interaction of semantic relationship and suffixation.

Category	Synonyms	Antonyms
Simple-Simple	13.503 (87.706)	5.613 (94.292)
Simple-Complex	12.367 (103.354)	14.965 (112.557)
Complex-Simple	27.015 (90.438)	-3.569 (83.898)
Complex-Complex	31.487 (78.551)	23.284 (85.481)

Figure 5-3: Priming effect (PE) pattern for each category of the interaction.



The pattern shows that semantically primed items are at least somewhat facilitated for all categories of the interaction except for the S-S and C-S antonym pairs.

5.4 Discussion

Basically, this priming experiment replicates the findings from earlier studies of semantic priming effects (Marslen-Wilson et al., 1994; and Den Heyer et al., 1985). Response times to items that were primed by a semantically related item (a synonym or antonym in this experiment) were faster than response times to those same items preceded by an unrelated prime. But, in contrast to the tradition in the literature in which different semantic relations are treated as a homogenous group, I found that synonyms and antonyms resulted in different patterns of priming.

Overall, items primed by their synonyms were more quickly responded to than items primed by their antonyms. This is the case even though no differences in response times were found to these same target items in the neutrally primed condition. The finding of no response time differences between the neutrally primed core stimulus items shows, overall, that these items had comparable recognition thresholds. The synonym and antonym control priming condition shows, therefore, that the stimuli were matched for properties relevant to lexical decision response time. Thus, it can only be the prime type, a synonym or antonym prime, that is causing the significant processing time differences between the two relations.

As was expected, the simple targets were more quickly responded to than the complex targets. This is likely because the complex items, besides

containing internal morphological complexity, were also orthographically longer. Complex targets may simply take more time to process because they require more reading time before they can be responded to. One interesting finding obtained from the interaction of semantic relation and morphological complexity was that, for simple targets, the antonyms had the processing advantage, while for complex targets the synonyms were better primes. Why this reversal took place cannot be explained with certainty, but it is possible that the extra processing time required for complex targets allowed the mismatch between response type (yes) and the "negative" antonymic relation to play a role.[1] This mismatch was not evident for the antonymic simple targets even when they were preceded by a complex item because, in this task, only responses to targets were analyzed.

In looking at the priming effect scores it is interesting to note that priming by synonymy is better than priming by antonymy. This is shown at all levels of morphological complexity with the exception of the S-C pairs in which antonyms seem to maintain a slight advantage. Again, it is possible that this effect is due to the mismatch that occurs in the processing of antonymic pairs in a task that required participants to respond yes to an essentially "negative" or "opposite" relation.

Another interesting difference found between synonyms and antonyms is that the antonyms, at the S-S and S-C levels, did not show

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[1] This mismatch was discussed in detail in Section 4.4.

any priming effects at all. There are two possible explanations that may account for this finding. First, it is possible that the response times to targets in the antonym pairs could not be responded to any quicker when semantically primed than when neutrally primed. This is in part supported by the fact that the simple antonym targets, regardless of prime type, were more quickly responded to than their synonymic counterparts. This, in effect, suggests that a "floor effects" played a role in these response times.

The other possibility is that inhibitory links exist for items that are directly related by antonymy. This direct antonymic relation would only occur for simple targets, as the immediate link between the items could be inhibitory. Only by forcing extra processing time would the semantic network in question have time to facilitate the items within the antonymic "network". This extra processing time required for the inhibitory link to be changed to a facilitatory one is present for the complex targets only.

The above arguments have provided evidence for why complex items may result in antonyms being more difficult to process (as in the case of the "mismatch" explanation) and for why these same complex items might actually help the antonymic link between items by allowing for an inhibitory link to change to a facilitatory one. In order to determine which of these, if either, explains the effect found for the antonymic pairs,

it would be necessary to find tasks that do not require a yes response to items in the "negative" antonymic relationships.

In summary, Experiment 2 suggests a reversal of the relative advantage of synonyms and antonyms when compared to Experiment 1. This indicates that the implicit and explicit tasks tap different aspects of on-line processing. Both experiments, however, provide evidence for the existence of fundamental differences between synonymic and antonymic links in the Mental Lexicon. This difference is especially visible with a controlled examination of the effects of suffixation on items in pairs that essentially represent synonymy and antonymy.

6. Concluding Remarks

6.1 The On-Line Experiments Compared

As was discussed at the outset of the thesis, my goal in this investigation was to contribute to knowledge in the area of psycholinguistics by focusing on the fundamental semantic relations of synonymy and antonymy and the extent to which these relations interact with morphological complexity. The study was organized to address three fundamental questions. These are discussed below in light of the results obtained from the pretest and the two experiments.

(1) Is there a difference in the links formed between words that are related by synonymy and words that are related by antonymy?

The results from the two on-line experiments raise a number of questions concerning the validity of analyzing all semantic relations together and assuming equivalent processing for all relations. When looking solely at the main effect of semantic relationship, no processing differences between synonymy and antonymy were found. In order to observe any real underlying differences it is necessary to examine the significant interactions in both on-line experiments that show synonymy and antonymy being differently affected by the addition of suffixation. Basically, this suggests that synonyms and antonyms behave in a similar

manner only on the surface, and that once morphological complexity is added to items, processing differences can be observed.

In the explicit task, the relatedness judgment experiment of Chapter 4, the antonym pairs showed a processing advantage at the S-S level, while showing no significant differences between the relations at all levels that contained at least one complex item. This happened in spite of the fact that the pretest showed, if anything, an antonymic advantage for all levels of morphological complexity. It was suggested that the addition of complexity hindered antonymic processing partly due to the nature of the task in which a yes response was required for the essentially "negative" antonymic relation.

The implicit task, the semantic priming experiment of Chapter 5, showed that, overall, synonyms were better primes than antonyms. But, contrary to the effect of suffixation for the explicit task, the addition of complexity on the target item seemed to increase priming effects. Two explanations were put forward to address this phenomenon. One suggestion was that, for simple targets, inhibitory links may be active, while the other explanation suggested that priming effects could be found due to a "floor effect" being reached for the simple antonym targets.

These results have important implications for studies that investigate effects of semantic relations by analyzing all types of semantic relations as being the same as long as they obtain high association ratings (for example, see Den Heyer, et al., 1985). Although significant effects were

found by Den Heyer, et al. (1985), it would be interesting to discover any effects caused by the different relations used. This fact that semantic relations are not all processed in the lexicon in the same way should also be taken into consideration when semantic processes are analyzed using only one relation (e.g., synonymy used in the semantic controls of the study by Marslen-Wilson et al., 1994) to produce conclusions about semantic relations in general.

A second basic question explored in this thesis was the following:

(2) Are semantically related words affected by the addition of suffixes to one or both items in the pair?

The manner in which suffixation has been shown to interact with semantic relations indicates that semantically related words are affected by suffixation. Thus the answer to the second experimental question seems to be 'yes'.

Although the precise effect that complexity plays cannot yet be determined, it can be concluded that the addition of suffixation does make a difference in the processing of semantic relations and that, minimally, this effect results in processing differences between synonyms and antonyms. The evidence that suffixation directly affects semantic relations is especially important due to the fact that suffixation seems to influence processing in a way that is above and beyond any differences that would be expected simply due to the need for extra processing time to strip lexical items of their suffixes. This effect was found for tasks that both require

explicit processing of synonymy and antonymy and implicit processing of these semantic relations.

The third basic question asked was the following:

3) Do implicit and explicit tasks generate different response patterns for word pairs related by synonymy and antonymy?

Again, the answer is affirmative. The pretest and Experiment 1 both employed tasks that tap explicit processing. In these tasks, the tendency was for antonyms to show greater ease of processing. Experiment 2, which tapped implicit processing, showed the opposite tendency. One important implication of this finding that different results could be found even between on-line experiments that employed identical stimulus sets is that results are very sensitive to the nature of the on-line paradigm. It is necessary, then, to use multiple tasks before drawing any definitive conclusions about the processing of semantic relations.

At this point in the psycholinguistic investigation of synonymy and antonymy the following account of the differences found between the explicit and implicit on-line tasks reported above seems most plausible: For an explicit task the participants attention is drawn to the existence of relationships between the items under examination. This would allow the possibly inhibitory link among words and their antonyms to be changed to a facilitatory one in order for the task to be performed. In more natural language processing, which can be seen by using a more implicit task, the links between words and their antonyms may maintain the inhibitory link. This organization would ensure that once a word is

recognized its antonym is not also activated as this may interfere with the processing of the initial word.

6.2 Future work

As was shown in Chapter 2, there is a lack of experimental literature that has focused on the comparative on-line processing of syonymy and antonymy and how these relations may be represented within the mental lexicon. In particular, there has been a lack of experimentation that has targeted the implicit processing of these relations. Thus, the experiments in this thesis are, by necessity, exploratory and can be seen as a subset of the many possible experiments that explore this issue. It is possible at this time to outline the nature of other investigations that would be useful in deepening our understanding of the role of synonymy and antonymy in the Mental Lexicon. In the sections below I discuss four possible areas of investigation. Two of these discuss stimulus characteristics while the other two focus on variations in the experimental paradigm.

6.2.1 The Use of Non-Neutral Affixation

In this study the relationship between synonymic and antonymic word pairs investigated the issue of morphological complexity by using neutral suffixation. It would also be worthwhile to investigate the effect of non-neutral suffixation. The role of this type of affixation can be seen as more complex because it may make the processing of links between related words both easier and more difficult. For example, in the case of the

antonymous pair happy and unhappy, once the word happy has been processed it is likely that the subsequent processing of unhappy would be made easier. This could be the case for numerous reasons. On one hand, it could be that the ease of processing is due to the great amount of orthographic overlap between happy and unhappy. Alternatively, it could be due to the fact that the actual lexical representation of the item unhappy consists of the item happy which would have already been accessed and would somehow be "linked" or "attached" to the morpheme un-. Both these possibilities would constitute instances of morphological complexity resulting in stronger semantic links between words and their morphological antonyms.

The addition of affixes could also be seen as creating an additional difficulty to the processing of semantically related words. This is apparent in the synonymous pair unhappy and sad where adding morphological complexity does not result in any orthographic overlap between the related items. It is also the case that a related pair such as unhappy and sad may be less easily understood as an instance of a synonymous pair, compared to monomorphemic pairs such as happy and glad, because while the complex-simple pair is made up of synonyms, its roots are antonyms.

6.2.2 A Comparison of Synonymic and Antonymic Subcategories

In this study it was necessary to take a broad sampling of stimulus pairs because this was a first attempt at studying and comparing explicit

and implicit synonymic and antonymic processing. It should be noted, however, that, overall, no differences were found in the subjects and items analyses. This suggests that, like the subjects, synonym and antonym items represented a random sampling of their populations.

Nevertheless, it might be profitable in future studies to systematically explore possible variations associated with subcategories of synonyms and antonyms.

6.2.3 Priming Paradigm using Naming Latency

In my discussion of both experiments an important factor in the interpretation of the results was that in both tasks a yes or no response was required.

Another type of on-line priming paradigm that probes implicit processing is naming latency. This paradigm uses the latency to name the items presented on the screen as the dependent variable. Besides allowing for a further examination of implicit processing effects, this type of task would automatically eliminate any effects that may have been caused by a mismatch in required response and relation type. This would be so because "positive" yes responses would not be required to the "negative" antonymic relation because participants would simply be required to read aloud lexical items as they appear on the screen.

6.2.4 Paired Priming

A paired priming task differs from the priming task used in Experiment 2 in that responses are only required for the targets. Typically, the prime is presented on the screen for a short period of time and is followed by the target to which the participant responds. Thus, the relatedness of the prime and target is made salient by the experimental procedure. This feature would allow a paired priming paradigm which measures priming effects as well as pairing the items to be comparable to the explicit relatedness judgment task that simply pairs the items for you.

The paired priming paradigm is also comparable to the non-paired priming task in that only responses to targets rather than to pairs are analyzed. Also, paired priming, as in the unpaired priming, looks at a spread of activation that one item causes for another item. Finally, a paired priming paradigm would also provide some evidence for what happens at a midpoint between explicit and implicit processing.

6.3 Summary

The results of the research presented in this thesis have suggested that there is a difference in the links formed between words related by synonymy and antonymy, that semantically related words are affected by the addition of suffixation, and that implicit and explicit tasks generate different response patterns. This points to the view that fundamentally different links may exist for different subtypes of semantic relations and

that models of lexical processing may need to posit both quantitative and qualitative differences among semantic links in the mental lexicon.

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Appendix A: Initial Stimulus List Used for the Rating Task

	Synonyms	Antonyms
Simple-Simple	garbage-trash	old-young
	couch-sofa	urban-rural
	large-big	correct-wrong
	grief-sorrow	fresh-stale
	stiff-rigid	far-near
	destroy-ruin	end-start
	close-shut	dark-light
	cash-money	strong-weak
	burn-scorch	always-never
	buy-purchase	hot-cold
	run-sprint	good-bad
	money-cash	love-hate
Simple-Complex	change-alteration	ugly-beautiful
	fast-speedy	copy-original
	deliberate-intentional	grace-awkwardness
	novice-beginner	whole-divided
	jealous-envious	faith-skepticism
	mute-voiceless	flat-bumpy
	brief-momentary	bend-straighten
	slick-slippery	simple-complicated
	appear-materialize	guilt-innocence
	test-examination	safe-dangerous
	profit earnings	same-different
	clever-skillful	clean-dirty
Complex-Simple	peaceful-serene	expensive-cheap
	deadly-fatal	ethical-corrupt
	collision-crash	conceited-modest
	verification-proof	generosity-greed
	breakable-fragile	fictitious-real
	alternative-choice	contaminated-pure
	faithful-loyal	agitated-calm
	astonishment-shock	healthy-sick
	wonderful-great	lower-raise
	wealthy-rich	domesticated-wild
	glaring-bright	subsequently-before
	sufficient-ample	failure-success

Complex-Complex		
	funny-humourous	angelic-demonic
	sickness-illness	cautious-daring
	annoying-bothersome	clearly-vaguely
	cheerfully-happily	talkative-speechless
	sleepy-tired	solidify-liquify
	appreciation-gratitude	required-optional
	active-lively	attractive-repulsive
	reduction-shrinkage	bravery-cowardice
	increasing-expanding	dryness-moisture
	lateness-tardiness	addition-subtraction
	betrayal-deception	arrival-departure
	favourable-advantageous	shorten-lengthen

Appendix B: Association Pair Ratings

The following pairs of words, used in the pretest and experiment 1, were taken from the Palermo & Jenkins (1967) corpus of association norms. The norms for males and females were averaged together for the purpose of this study.

Word Pair	Rating	Word Pair	Rating
afraid-fear	278	loud-noise	231
bible-god	316	moon-star	236
bitter-sweet	544	mountain-hill	213
black-white	585	needle-thread	457
blossom-flowers	629	now-then	378
blue-sky	252	ocean-water	362
butter-bread	575	only-one	359
cold-snow	209	salt-pepper	408
cottage-house	264	scissors-cut	678
cry-baby	284	shoes-feet	358
doors-windows	358	sit-down	271
dream-sleep	485	so-what	286
eagle-bird	576	sour-sweet	487
eating-food	423	spider-web	378
fingers-hand	341	stem-flower	398
foot-shoe	255	table-chair	691
fruit-apple	450	thief-steal	264
green-grass	412	thirsty-drink	289
hammer-nail	449	tobacco-smoke	482
hand-foot	228	anger-mad	352
guns-shoot	201	appear-see	218
hungry-food	413	priest-church	225
justice-law	243	king-queen	651
kittens-cats	373	lift-carry	208
lamp-light	706	lion-tiger	216

Appendix C: Synonym Ratings

Word pair	Mean rating from pretest
garbage-trash	4.737
couch-sofa	4.684
large-big	4.526
grief-sorrow	4.316
stiff-rigid	4.263
destroy-ruin	4.263
close-shut	4.158
cash-money	4.132
burn-scorch	3.900
buy-purchase	4.842
change-alteration	4.474
fast-speedy	4.421
deliberate-intentional	4.421
novice-beginner	4.389
jealous-envious	4.368
mute-voiceless	4.105
brief-momentary	4.105
slick-slippery	4.000
appear-materialize	3.684
test-examination	4.526
peaceful-serene	4.579
deadly-fatal	4.474
collision-crash	4.263
verification-proof	4.211
breakable-fragile	4.211
alternative-choice	4.158
faithful-loyal	4.105
astonishment-shock	4.053
wonderful-great	3.789
wealthy-rich	4.684
funny-humourous	4.684
sickness-illness	4.474
annoying-bothersome	4.421
cheerfully-happily	4.158
sleepy-tired	4.105
appreciation-gratitude	3.947
active-lively	3.842
reduction-shrinkage	3.632
increasing-expanding	3.632
lateness-tardiness	4.684

Appendix D: Ratings for Antonyms

Word pair	Mean rating from pretest
old-young	4.895
urban-rural	4.263
correct-wrong	4.579
fresh-stale	4.632
far-near	4.684
end-start	4.737
dark-light	4.789
strong-weak	4.842
always-never	4.789
hot-cold	4.895
ugly-beautiful	4.737
copy-original	3.632
grace-awkwardness	3.789
whole-divided	4.105
faith-skepticism	4.158
flat-bumpy	4.211
bend-straighten	4.263
simple-complicated	4.579
guilt-innocence	4.632
safe-dangerous	4.684
expensive-cheap	4.684
ethical-corrupt	4.000
conceited-modest	4.053
generosity-greed	4.158
fictitious-real	4.158
contaminated-pure	4.263
agitated-calm	4.474
healthy-sick	4.526
lower-raise	4.632
domesticated-wild	4.632
angelic-demonic	4.684
cautious-daring	4.158
clearly-vaguely	1.182
talkative-speechless	4.263
solidify-liquify	4.368
required-optional	4.421
attractive-repulsive	4.536
bravery-cowardice	4.526
dryness-moisture	4.526
addition-subtraction	4.684